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Reducing calories, fat, saturated fat and sodium in restaurant menu items: Effects on consumer acceptance

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Abstract

OBJECTIVE—This study assessed consumer acceptance of reductions of calories, fat, saturated fat, and sodium to current restaurant recipes.

METHODS—Twenty-four menu items, from six restaurant chains, were slightly modified and moderately modified by reducing targeted ingredients. Restaurant customers (n=1,838) were recruited for a taste test and were blinded to the recipe version as well as the purpose of the study. Overall consumer acceptance was measured using a 9-point hedonic (like/dislike) scale, likelihood to purchase scale, Just-About-Right (JAR) 5-point scale, penalty analysis and alienation analysis.

RESULTS—Overall, modified recipes of 19 menu items were scored similar to (or better than) their respective current versions. Eleven menu items were found to be acceptable at the slightly modified recipe version and eight menu items were found to be acceptable at the moderately modified recipe version. Acceptable ingredient reductions resulted in a reduction of up to 26% in calories and a reduction of up to 31% in sodium per serving.

CONCLUSIONS—The majority of restaurant menu items with small reductions of calories, fat, saturated fat and sodium were acceptable. Given the frequency of eating foods away from home, these reductions could be effective in creating dietary improvements for restaurant diners.

Keywords

restaurants; recipe modification; consumer acceptance; nutrition; public health

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Introduction

Obesity remains a public health issue, with nearly 38% of U.S. adults classified as obese (1). The increase in obesity prevalence over the last 15 years (1) parallels overall food consumption and expenditure patterns that show a greater reliance on food away from home (FAFH), including food purchased at fast-food and full-service restaurants (2). Americans consume about 32% of their calories from FAFH (3). Compared to meals prepared at home, FAFH contains more calories, total fat, saturated fat, sodium and added sugars, and less desirable nutrients including calcium and iron (4).

Researchers have found an association between frequent eating out and higher caloric intake, weight gain and obesity (5). With nearly half of consumers' food budgets being spent on FAFH (2), the restaurant industry has been implicated as a major factor contributing to the obesity epidemic (6). Improving the restaurant nutrition environment may be an effective strategy for creating dietary improvements for restaurant-diners (7, 8). The 2010 Patient Protection and Affordable Care Act (ACA) includes provisions that require restaurants with 20 or more locations to provide nutrition information; the Food and Drug Administration (FDA) released the final rule for this provision in April 2016 and will begin enforcing the final rule on May 5, 2017 (9). Although this public health strategy holds potential to help some consumers choose healthier options, results from a systematic review and meta-analysis indicate that menu labeling with calories alone did not decrease calories consumers selected or consumed (10). Demographic characteristics and consumer preferences predict use of nutrition information (11, 12) with only a subset using nutrition information to make healthful choices (11). This may be due to the barriers consumers face in understanding nutrition information including confusion about caloric values, as well as competing priorities of taste (11), price, time, preference, hunger, and habitual ordering (13). Menu labeling will not benefit consumers who lack the motivation and desire to utilize it (14). Therefore, in addition to menu labeling, public health efforts that influence restaurant food consumption are warranted.

Many restaurant chains offer lower-calorie, lower-sodium and healthful choices (15, 16); however, these efforts may only reach the motivated "health-conscious" or "special-diet" consumers. Other consumers may perceive healthier choices to be smaller in portion size, more expensive (17) and /or lack flavor (17, 18). Taste and presentation are the two greatest factors influencing satisfaction and behavioral intentions (19). Therefore, instead of introducing new, 'healthy' menu items, restaurants can focus on making small changes to their top selling items to make them healthier (17). Ultimately, meeting consumer demand in order to maximize profit is salient to restaurant operators for changing their menus and serving healthier options (20). Therefore, the restaurant industry is facing a challenge to produce healthier menus that do not compromise taste and consumer acceptance.

Improving the restaurant nutrition environment by modifying popular and indulgent menu items to contain less calories, fat, saturated fat and sodium may be among the most effective strategies for creating dietary improvements for populations who choose these types of items when eating at restaurants. Creating small but meaningful changes to restaurant menu items removes the onus on the consumer to choose or request "healthier" versions of their favorite

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items. Furthermore, reducing the quantities of high-fat, high-sodium items such as creamy sauces, dressings, bacon, and cheese could lead to lower food costs for restaurants. The present study examined the effect of reduced calorie, fat, saturated fat and/or sodium menu items on overall consumer acceptance. This is the first study of its kind to test this strategy in a real-life restaurant setting, recruiting current restaurant customers, and working with the restaurant companies as key stakeholders in public health. Ultimately, the success of this public health strategy depends on enhancing private-public partnerships and collaboration. We hypothesized that restaurant menu items with slight to moderate reductions in ingredients that contribute to extra calories, fat, saturated fat and/or sodium would be as well-liked and acceptable as current versions. The current paper presents preliminary data on the effects of modified menu items on consumer acceptance.

Methods

Overall consumer acceptance of two modified versions of 24 menu items from six restaurant chains were evaluated and compared to their current version. Four restaurant types were included in the study: quick service (fast food), fast-casual, buffet and full service. Current recipes from each restaurant were obtained from the restaurant's corporate executives. Modified recipes were jointly agreed upon with restaurant executives and study personnel, and designed to be operationally feasible for the restaurant’s supply chain, kitchen equipment and cooking utensils. The taste tests were conducted at four locations per restaurant chain throughout the United States. Twelve menu item versions (three recipe versions of four menu items) were tested at each participating restaurant location. For each menu item, one or more ingredients were selected as “target(s)”. Each menu item was modified to give two menu item versions: 1) ≤ 16% less calories and ≤ 28% less sodium, and 2) ≤ 26% less calories and ≤ 43% less sodium. The main components of the menu items were not reduced in order to ensure that portion size was unaffected. The taste tests included three recipe versions (1) current menu item (C), (2) slightly reduced calorie, fat, saturated fat and/or sodium version (V1), and (3) moderately reduced calorie, fat, saturated fat and/or sodium version (V2). Table 1 shows the target ingredients as well as the nutrition information for each of the menu items and their respective modified versions.

The items tested included three side dishes (hummus, seafood nachos, white beans), two soups, three creamy salads which included mayonnaise (potato, seafood, chicken), two vinaigrette-based green salads, one pizza, three pastas/casseroles, four burgers, four sandwiches and two seafood dishes. Preparation of all items was similar to how the item would be normally prepared during regular operations. The bacon cheeseburger was served whole with a condiment caddy, without any sides or fries. All other burgers and sandwiches were served in halves, without any condiments or side dishes. The hummus was served with pita bread. The seafood nachos, fish, seafood platter and creamy Alfredo pasta with shrimp were served “family-style” with participants serving themselves.

Recruitment

Participants were recruited via each restaurant’s marketing team and their customer email list. Inclusion criteria were: 1) having previously ordered at least two of the menu items

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being tested, 2) willingness to try all of the menu items being tested, and 3) availability for at least one of the taste test session times. Exclusion criteria were: 1) being less than 18 years of age or more than 70 years of age, 2) never having eaten at the restaurant, 3) having participated in a survey or research study involving food or beverages more than two times in the last three months, 4) having worked (or having family who have worked) for the restaurant, 5) allergies to, or personal dietary restrictions toward, the taste test food/ ingredients, and 6) responding “definitely would not try” to any of the taste test items.

The participants were randomized into three groups of approximately 25 people each over three separate sessions per restaurant location. An example of the randomization and balanced position order of menu items is shown in Table 2. Participants were blinded to the purpose of the study. They were provided the name of the menu item only and were not informed that menu items may have been modified. Participants sampled four menu items total (only one version per menu item). All taste test sessions were conducted in a designated area within the restaurant. The test environment simulated a real dining experience; however, participants were instructed to refrain from sharing feedback with other participants. All condiments, salt/pepper shakers, and promotional materials were removed from the tables. Participants were instructed to take at least three bites of each item, but were not required to finish any item. After each tasting, the menu item was cleared and the next menu item was presented. Participants were given 20 minutes to consume each menu item and complete a paper questionnaire, customized for each of the menu items tested. Room temperature water was provided to cleanse the palate between menu items. Restaurant gift cards in amounts ranging from $15 to $25 were provided as an incentive. A total of 1838 participants participated in 83 separate taste test sessions.

Measurements

Nine-point hedonic (like-dislike) scales were used for overall liking, appearance, aroma, taste/flavor and texture/consistency (21). Generalized linear regression models were used to assess the differences in the mean scores of participants’ responses to these variables between different menu items. In all analyses, statistical significance was set at 0.05. The JAR (Just-About-Right) analysis distributed the JAR scores into three categories: too much of a certain ingredient, Just-About-Right, and not enough of a certain ingredient. A desirable set of responses on the Just-About-Right scale is centered on a high proportion of responses in the “just-right” category, symmetry, and low frequencies in the extremes of the scale (22). Penalty analysis combined the JAR scale information with the hedonic scale data by comparing the mean hedonic scores that were above (or below) the JAR point, to menu items scored as “Just-About-Right” in that particular ingredient or attribute. Alienation analysis examined the proportion of scores on the negative (or negative plus neutral) side of the hedonic scale. Scores of 4 or less (“alienation”) and 5 or less (“alienation” plus neutral counts) were counted. Modified menu items were considered acceptable if, compared to the current version, the modified version showed: 1) no significant differences (or a significant increase in scores) on the 9-point scale for overall taste/flavor and overall opinion, 2) similar (i.e., within 5%) or an increased likelihood to purchase, 3) similar or an improvement in the JAR distributions and penalty analysis, and 4) similar (i.e., within 5%) or a decrease in alienation frequencies. For reporting purposes, the mean scores of the overall taste/flavor (9–

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point hedonic scale), specific JAR distribution scores, penalty analysis for selected menu items, and the likelihood to purchase data are presented. This study was approved by BioMed institutional review board in San Diego, California.

Results

Participant demographic characteristics are shown in Table 3. The majority of participants were women (63%) and white (67%). Table 4 shows the consumption frequency for each menu item (i.e., how often participants ordered the menu item). Calorie, fat, saturated fat and sodium reductions for accepted modified recipe versions are presented in Table 5. In general, compared to their current versions, at least one modified version of all the soups, creamy salads, pizza, pastas/casseroles and seafood dishes was found to be acceptable.

Drawing from the aforementioned analyses, the modified recipes of 19 menu items were scored similar to (or better than) their respective current versions, while the modified recipes of five menu items were scored lower than their respective current versions (See Table 1). Eleven menu items' V1 were found to be acceptable and eight menu items' V2 were found to be acceptable. Ingredient reductions among the acceptable menu item versions ranged from 10–100%, which resulted in reductions of up to 26% in calories and up to 31% in sodium. Table 6 indicates participants' likelihood to purchase each of the menu item versions. The likelihood to purchase was similar (i.e., within 5%), or in some cases higher for all accepted menu items' V1 or V2, compared to the current version.

Mean scores on the 9-point hedonic scale for the overall taste/flavor of all menu item versions are shown in Table 7. Overall taste/flavor for V1 and V2 were rated similarly to C for 17 menu items (i.e., there were no significant differences between either of the modified versions and C). Overall taste/flavor for V2 of the seafood platter rated significantly higher than C suggesting that this version was preferred by participants ($p<0.05$). The JAR distributions and penalty analysis for Saltiness and Amount of Dressing for selected menu items are shown in Table 8. The frequency of responses for "too salty" was high for the current and modified versions of both soups (broccoli cheddar and chicken) and the seafood platter. Moreover, the seafood platter (C and V1) was penalized in terms of overall liking. The proportion of "just-right" scores improved slightly for the potato salad and hummus for their V1 and/or V2. The frequency of responses for "too much" dressing was high for the current and modified versions of the creamy salads (potato, seafood, chicken) and several versions were penalized in terms of overall liking.

Of the five modified menu items that were not acceptable to participants, two V1 recipes (white beans and beef & cheddar sandwich) were rated significantly lower in overall taste/flavor than C ($p<0.05$). Compared to C, three of the V1 modified recipes (green salad with blue cheese, Greek salad, guacamole chicken burger) were rated similar or lower in overall taste/flavor (not significant); however, the V2 rated significantly lower in overall taste/flavor ($p<0.05$).

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Discussion

Preliminary findings indicate that 19 of the 24 menu items with slight to moderate reductions of calories, fat, saturated fat and sodium were as well-liked and acceptable as the current recipes of those items. Notably, the buffet items (creamy salads, chicken casserole, meat lasagna) were all acceptable with reductions in mayonnaise, creamy dressing and/or cheese. Reductions in cheese, fried onions and/or bacon on all three beef patty burgers were acceptable. The majority of sodium-reduced menu items (hummus, chicken soup, broccoli cheddar soup, potato salad, seafood platter) were all acceptable with reductions in salt or seasoning.

Menu items with a high fat content generally have a relatively high energy density. Modest changes in energy density can have a significant impact on daily energy intake when a person consumes a consistent weight of food (23). For the buffet items and the hummus, we lowered the energy density by reducing the high fat ingredients, which increased the weight of higher-moisture ingredients. Our results are consistent with other research showing no significant effect on taste ratings of six entrees after reducing fat and energy density (24, 25). The high frequency of “too much” dressing on the JAR scale for all three creamy salads suggests that dressings could be reduced without compromising acceptance. Reductions in energy density, while maintaining satisfying portions, can significantly decrease energy intake while maintaining satiety (26).

In the present study, modified ingredients in the beef patty burgers were found to be acceptable. This may be because acceptance was based on the juiciness, tenderness and flavor liking of the beef patty itself, which was not modified. Other research showed consumer overall liking of beef strip loin steaks was correlated with tenderness and juiciness ratings, but most highly correlated with flavor liking (27). Additionally, taste expectations can be influenced by previous experiences with a food product, and these effects are dependent upon consumption frequency (28). In this study, the appearance of the modified burgers was similar to the current versions and the ingredient reductions may not have been noticeable, which may have resulted in a positive liking expectation. Therefore, it is possible that participants’ positive expectations of the food influenced the acceptance (29).

Consistent with our results, reduced-sodium products were as well-liked as their current versions (30, 31). We targeted sodium in hummus, potato salad, chicken soup, seafood platter, broccoli cheddar soup and white beans by reducing salt, seasoning or soup base. The slight to moderate versions of five out of the six items were acceptable to participants and also had the highest likelihood to purchase, compared to current versions. The high frequency of “too salty” responses on the JAR scale suggests that the sodium-containing ingredients could be reduced further without compromising acceptance. In a similar study, the salt reduction in a chicken stew was not compensated for by majority of participants (i.e., they did not add any table salt) (30). Moreover, in a randomized controlled trial, reduced-sodium foods did not trigger compensation behavior during the remainder of the day in the intervention group compared to the control group (31). Therefore, reducing sodium in menu items may also contribute to an overall reduction in daily sodium intake.

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Further research examining menu items that were not acceptable to participants may also be warranted. The modifications to relatively lower calorie and fat menu items, such as the guacamole chicken burger and both vinaigrette-based salads, were not acceptable to participants. For the vinaigrette-based salads in particular, acceptance may have been affected by the overall appearance of the dish. Several participants voiced comments about the green salad being void of dressing on the modified versions. The modified versions of the white beans were also not acceptable to participants. Modifying ingredients such as blue cheese, feta and white beans may require further examination with participants who are screened for liking such ingredients and/or frequently consuming the menu item. For sandwiches, reducing certain ingredients may have been too noticeable (e.g., 2 pieces of cheese reduced to 1 piece), potentially affecting the expected liking, which has been found to ultimately affect food acceptance (29). Although modified recipes were based on operational feasibility, there may be a point between the slight and moderate versions that may be acceptable. Further research examining changes to lower-fat and/or lower-sodium ingredients, while maintaining the current recipe, may be more operationally feasible for some menu items and have a significant impact on calories and/or sodium consumed while dining at restaurants.

This study was conducted in partnership with the restaurant companies, which was considered a major strength, as restaurant recipes are proprietary. Menu items were mutually agreed upon with the restaurants' corporate executives/chefs, with realistic modifications. Furthermore, menu items were prepared as they would be during normal operations by the restaurants' own personnel. To account for geographic differences, four different restaurant locations were selected for each restaurant company.

This study had several limitations. Primarily, it was difficult to establish what impact this sample had on generalizability of this research because the restaurants' menu items were tested by their customers, with the majority of participants having previous experience with the items. The consumption frequency was not the same for the three versions of several menu items tested (see table 4). Particularly, the percentage of participants who had no familiarity with (i.e., never ordered) the menu item version differed by more than 10% for several of the menu items. However, if previous consumption of the menu item increases familiarity, any modification could potentially lead to alienation and non-acceptance of the modified menu item. Further research exploring consumption frequency and its influence on liking is needed to examine how this variable may or may not bias overall acceptance for modified menu items. Another limitation included sample size variations in some of the menu items' versions due to execution errors in the kitchen and/or errors on the questionnaires. Although each menu item recipe version was standardized, the preparation of any given menu item may have differed. For example, the scales used in different locations may have produced slight differences in ingredient measurements. Finally, restaurant locations were nationwide, and ingredient distribution/suppliers for certain ingredients may have been different for the same menu items.

One of the goals of this study was to collaborate with the restaurant companies to test popular, indulgent menu items while simultaneously reducing ingredient costs and maintaining operationally feasible recipes with acceptable flavor profiles. Restaurants sell

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what people will buy and do not perceive it as their responsibility to increase demand for healthier food items (32). The majority of chefs surveyed in one study felt that calories in restaurant menu items could be decreased by 10 to 20% before customers would notice (33). In this study, the majority of menu items' slight to moderate reductions in calories, fat, saturated fat and sodium were found to be acceptable and had little or no effect on taste/flavor ratings or likelihood to purchase. Previous research indicates that the provision of acceptable lower fat, lower calorie meals at restaurants (without labeling the meal as such) resulted in a reduction of consumers' fat and energy intake, which was not compensated for by other components of the meal (34). Further studies are needed to extend our findings to longitudinally examine whether the acceptable modified recipes in this study would remain acceptable over time, and/or promote overall healthier eating patterns.

Conclusion

Reducing calories, fat, saturated fat and sodium of restaurant meals to an equally liked and acceptable level may be a strategy to improve consumers' dietary intake when eating in restaurants. This approach takes the burden off the consumer to make healthier choices. Acceptable modified menu items included reductions of up to 210 calories, 20g fat, 8g saturated fat (≤ 26% of calories) and 1970mg sodium (≤ 31% sodium) per serving. Coordinated efforts among the restaurant industries and public health organizations hold important potential in understanding the most effective ways to develop lower calorie, fat, saturated fat and sodium items, while ensuring that costs are controlled and taste and acceptance are not compromised.

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Study Importance Questions

- The increase in obesity prevalence over the last 15 years parallels overall food consumption and expenditure patterns that show a greater reliance on food away from home (FAFH), including food purchased at fast-food and full-service restaurants
- Americans consume about one third of their calories from FAFH
- Compared to meals prepared at home, restaurant food contains more calories, total fat, saturated fat and sodium.
- This study discusses public health implications of a strategy to improve the restaurant nutrition environment by modifying current and popular menu items to contain less calories, fat, saturated fat and/or sodium.

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Table 1

Ingredient reductions and nutrition information of all menu items

Menu Items	Ingredient Reductions	% calorie reductions	% sodium reductions	Energy (kcal)	Total fat (g)	Calories from fat	Saturated fat (g)	Cholesterol (mg)	Sodium (mg)
Hummus[a^]	Canola & Olive Oil; Salt								
C	2.0 cups; 2.0 Tbsp			320	19	170	2	0	640
V1[b]	1.5 cups; 1.5 Tbsp	6.25%	10.94%	300	17	150	2	0	570
V2[b]	1.0 cup; 1.0 Tbsp	12.50%	23.44%	280	14	130	1.5	0	490
Seafood Nachos	Crab dip								
C	7.0 fl. Oz			2030	145	1290	49	310	2700
V1	6.0 fl. oz	2.96%	6.30%	1970	140	1250	46	275	2530
V2	5.0 fl. oz	6.40%	12.22%	1900	135	1200	43	235	2370
White beans[a^]	Canola & Olive Oil; Salt								
C	2.0 cups; 1.0 Tbsp			260	13	110	1	0	800
V1[b]	1.5 cups; 0.75 Tbsp	11.54%	6.25%	230	10	90	0.5	0	750
V2[b]	1.0 cup; 0.5 Tbsp	19.23%	12.50%	210	7	60	0	0	700
Chicken soup[c^]	Salt								
C	6.0 tsp			140	6	50	1.5	30	1270
V1	5.0 tsp	0.00%	9.45%	140	6	50	1.5	30	1150
V2	4.0 tsp	0.00%	18.90%	140	6	50	1.5	30	1030
Broccoli cheddar soup[a^]	Cream Soup Base; Cheese Sauce Mix								
C	16.0 cups; 16.0 oz			190	9	90	4	0	1070
V1	14.0 cups; 14.0 oz	5.26%	9.35%	180	8	80	3.5	0	970
V2	12.0 cups; 12.0 oz	26.32%	26.17%	140	7	60	2.5	0	790
Potato salad[d^*]	Mayonnaise; Salt								
C	20.0 fl. oz; 1.5 tsp			310	26	230	4.5	45	600
V1	17 fl. oz ; 0.75 tsp	3.23%	10.00%	300	24	220	4.5	45	540

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Menu Items	Ingredient Reductions	% calorie reductions	% sodium reductions	Energy (kcal)	Total fat (g)	Calories from fat	Saturated fat (g)	Cholesterol (mg)	Sodium (mg)
V2	15 fl. oz ; 0 tsp	6.45%	18.33%	290	23	210	4	45	490
Seafood salad[d^*]	Mayonnaise; Ranch Dressing								
C	1.5 cups; 8.0 fl. oz			200	14	120	3	25	780
V1	1.25 cups; 7.0 fl. oz	10.00%	0.00%	180	12	110	3	25	780
V2	1.0 cup; 6.0 fl. oz	15.00%	−1.28%	170	10	90	2.5	25	790
Chicken salad[e^*]	Salad Dressing, Ranch; Sour Cream; Mayonnaise								
C	2.0 cups; 8.0 Tbsp; 8.0 Tbsp			330	21	190	3.5	95	420
V1	1.75 cups; 6.0 Tbsp; 6.0 Tbsp	6.06%	7.14%	310	19	170	3.5	95	390
V2	1.5 cups; 5.0 Tbsp; 5.0 Tbsp	9.09%	14.29%	300	17	160	3	95	360
Green salad with blue cheese[f∞]	Blue Cheese Crumbles; Dijon Vinaigrette Dressing								
C	1.0 oz; 2.0 fl. oz			680	37	330	10	105	1410
V1	5.0 tsp; 1.5 fl. oz	16.18%	27.66%	570	29	260	7	90	1020
V2	4.0 tsp; 1.0 fl. oz	26.47%	43.26%	500	23	210	5	85	800
Greek salad[∞]	Feta Cheese								
C	2.0 oz			760	38	330	14	150	2140
V1	1.5 oz	5.26%	7.94%	720	35	310	12	140	1970
V2	1.0 oz	10.53%	15.89%	680	32	280	10	130	1800
Meat Pizza[g^]	Cheese; Pepperoni; Canadian Bacon; Italian Sausage; Beef Topping; Pork Topping								
C	5.0 oz; 0.4 oz; 1.0 oz; 2.0 oz; 2.0 oz; 2.0 oz			300	13	110	6	35	720
V1	4.5 oz; 0.4 oz; 1.0 oz; 1.5 oz; 1.5 oz; 1.5 oz	6.67%	13.89%	280	11	100	5	30	620
V2	4.0 oz; 0.4 oz; 1.0 oz; 1.25 oz; 1.25 oz; 1.25 oz	13.33%	22.22%	260	10	90	4.5	30	560
Creamy Alfredo pasta with Shrimp	Alfredo Sauce								
C	6.0 fl. oz			1460	78	690	35	400	3560
V1	5.0 fl. oz	5.48%	4.78%	1380	71	620	30	380	3390
V2	4.0 fl. oz	11.64%	9.55%	1290	63	560	26	360	3220

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Menu Items	Ingredient Reductions	% calorie reductions	% sodium reductions	Energy (kcal)	Total fat (g)	Calories from fat	Saturated fat (g)	Cholesterol (mg)	Sodium (mg)
Chicken casserole[e^]	Cheese; Tortilla Chips; Cream of Chicken Soup; Chicken								
C	2.0 quarts; 32.0 oz; 4 cans; 96.0 oz		250	13	110	5	35	610	
V1	1.75 quarts; 30.0 oz; 3.5 cans; 80.0 oz	4.00%	0.00%	240	12	110	5	35	610
V2	1.5 quarts; 22.0 oz; 3 cans; 65.0 oz	8.00%	1.64%	230	11	100	5	30	600
Meat lasagna[e^]	Beef Topping; Cheese								
C	10.0 lb; 6 quarts			250	10	90	4.5	30	650
V1	8.0 lb; 5 quarts	4.00%	3.08%	240	9	80	4	25	630
V2	7.0 lb; 4 quarts	8.00%	6.15%	230	8	70	3.5	25	610
Bacon cheeseburger	Cheese; Bacon; Cheese Spread								
C	2 slices; 3 slices; 1.0 Tbsp		1160	72	650	29	235	2070	
V1	1 slice; 3 slices; 0.5 Tbsp	10.34%	19.32%	1040	61	550	24	220	1670
V2	1 slice; 2 slices; 0 Tbsp	18.10%	30.92%	950	52	470	21	215	1430
Beef burger with blue cheese	Blue Cheese Crumbles; Chipotle Mayonnaise; Fried onions								
C	1.5 oz; 1 oz; 1.5 oz			1380	85	760	24	140	2140
V1	1.33 oz; 5 tsp; 1.33 oz	5.80%	6.07%	1300	79	710	22	135	2010
V2	1.0 oz; 5.0 tsp; 1.0 oz	15.22%	14.95%	1170	70	630	20	125	1820
Beef burger with barbecue sauce	Fried Onions; Mayonnaise; Mayonnaise, Lite								
C	1.5 oz; 1.0 oz; 0			1440	93	840	24	150	1760
V1	1.33 oz; 5.0 tsp; 0	6.25%	3.41%	1350	86	780	23	145	1700
V2	1.0 oz; 0; 5 tsp	19.44%	3.98%	1160	69	620	20	135	1690
Guacamole chicken burger	Butter; Mayonnaise; Mayonnaise, Lite; Bacon; Guacamole								
C	9.0g; 0.5 fl. oz; 0; 3 slices; 1.0 fl. oz			820	46	420	12	115	1810
V1	4.5g; 2.0 tsp; 0; 2 slices; 1.0 fl. oz	13.41%	9.94%	710	35	320	10	105	1630
V2	0; 0; 2.0 tsp; 2 slices; 0.75 fl. oz	25.61%	13.26%	610	25	230	8	100	1570
Italian sandwich	Salami; Pepperoni; Ham; Cheese; Mayonnaise								

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Menu Items	Ingredient Reductions	% calorie reductions	% sodium reductions	Energy (kcal)	Total fat (g)	Calories from fat	Saturated fat (g)	Cholesterol (mg)	Sodium (mg)
C	5 slices; 3 slices; 2.0 oz; 2 slices; 1.0 oz			920	57	520	16	105	2370
V1	4 slices; 3 slices; 1.75 oz; 2 slices; 0.5 oz	15.22%	9.28%	780	44	400	14	90	2150
V2	3 slices; 2 slices; 1.5 oz; 1 slice; 0.5 oz	22.83%	21.52%	710	39	350	12	75	1860
Turkey sandwich with bacon	Bacon; Cheese; Ranch; Mayonnaise								
C	3 pieces; 2 slices; 1.0 oz; 1.0 oz			840	49	440	12	85	2240
V1	3 pieces; 2 slices; 1.0 oz; 0.5 oz	11.90%	2.68%	740	38	340	10	80	2180
V2	2 pieces; 1 slice; 0.5 oz; 0.5 oz	26.19%	16.96%	620	28	250	6	60	1860
Meatball sandwich	Meatballs; Cheese								
C	5 pieces; 2 slices			820	50	450	19	95	1910
V1	4 pieces; 2 slices	10.98%	9.95%	730	42	380	16	80	1720
V2	4 pieces; 1 slice	17.07%	16.23%	680	38	340	14	70	1600
Beef and cheddar sandwich	Brisket; Cheese; Mayonnaise								
C	4.0 oz; 2 slices; 1.0 oz			890	59	530	19	105	1690
V1	3.5 oz; 2 slices; 0.5 oz	15.73%	8.88%	750	44	400	16	90	1540
V2	3.0 oz; 1 slice; 0.5 oz	24.72%	18.93%	670	37	330	12	70	1370
Fish	Alfredo Sauce								
C	1.5 fl. oz			1100	76	690	34	200	2050
V1	1.25 fl. oz	1.82%	1.95%	1080	75	670	33	195	2010
V2	1.0 fl. oz	3.64%	4.39%	1060	73	650	32	190	1960
Seafood platter	Seasoning Paste								
C	2.0 fl. oz			1260	77	690	31	280	10120
V1	1.75 fl. oz	0.00%	9.58%	1260	77	690	31	280	9150
V2	1.5 fl. oz	0.79%	19.17%	1250	76	690	31	280	8180

Menu items were analyzed by a registered dietitian using Genesis R&D, 9.14.41 database structure version 9.8.2 June 2015. The nutrition analysis for all four sandwiches were provided by the restaurant. Nutrition information per serving size.

Modified menu items were considered acceptable if, compared to the current version, the modified version showed: 1) no significant differences (or a significant increase in scores) on the 9-point scale for overall taste/flavor and overall opinion, 2) similar (i.e., within 5%) or an increased likelihood to purchase, 3) similar or an improvement in the JAR distributions and penalty analysis, and 4) similar (i.e., within 5%) or a decrease in alienation frequencies.

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Acceptable versions are highlighted in grey.

C=current menu item
V1= slightly reduced calorie, fat, saturated fat and/or sodium version
V2=moderately reduced calorie, fat, saturated fat and/or sodium version
oz = Ounces; fl = fluid; Tbsp = tablespoon; tsp = teaspoon

^ Ingredient reductions based on bulk recipe

* Creamy salads that use mayonnaise, yogurt or sour cream as a base

∞ Vinaigrette-based salads that use oils and vinegars as a base

[a] analysis for 6.0 fluid ounces

[b] Water was added to recipe so that the product yield remained the same as the current recipe

[c] analysis for 10.0 fluid ounces

[d] analysis for 4.0 ounce weight

[e] analysis for 6.0 ounce weight

[f] Menu item includes chicken, dried fruit and nuts

[g] analysis for 2 slices

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Table 2

Example of randomization and balanced position order of menu items for one restaurant company

Restaurant Location*	**CA**			**NY**			**TX**			**NM**		
Taste test Session	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	A1	B2	C1	D2	C2	A3	B1	A2	D1	C3	B3	D3
	B3	C2	D3	C1	A1	D1	A3	C3	B2	A2	D2	B1
	C3	D1	A2	B3	D3	B1	C1	D2	A1	B2	A3	C2
	D2	A3	B1	A2	B2	C3	D3	B3	C2	D1	C1	A1

Participants were randomized into three groups over three separate sessions per restaurant location.

*CA=California; NY=New York; TX=Texas; NM=New Mexico

A=Bacon cheeseburger; B=Meat Pizza; C=Chicken Salad; D=Chicken Casserole

1=Current menu item (C); 2=Slightly reduced calorie, fat, saturated fat and/or sodium version (V1); 3=Moderately reduced calorie, fat, saturated fat and/or sodium version (V2)

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Table 3

Demographic characteristics of participants

Characteristic[a]	%	n
Gender (n=1838)		
Male	37.1	683
Female	62.6	1150
Prefer not to answer	0.3	5
Mean age, years (n=1838)		
18 to 25	6.3	115
26 to 40	34.5	634
41 to 55	36.6	672
over 56	21.5	396
Prefer not to answer	1.1	21
Race (n=1808)		
American Indian/Alaska Native	1.3	24
Black/African American	14.6	264
White	66.7	1206
Asian[b]	7.0	127
Mixed Race and Other	9.3	167
Prefer not to answer	1.1	20
Show rates		
Attendance[c]	92.8	1705
Walk-ins[d]	7.2	133

[a] Individual n values vary due to missing data.

[b] Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, or other Asian

[c] Attendance= screening, registering and signing consent prior to taste test session

[d] Walk-ins = on-site eligibility screening

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Table 4

Consumption frequency of menu items

Menu Items	Item Version	Never	<1/mo	1/mo	1/2-3wk	>1/wk	>2/wk
Hummus	C (n=103)	30.1%	16.5%	17.5%	19.4%	12.6%	3.9%
	V1 (n=99)	29.3%	20.2%	25.3%	16.2%	7.1%	2.0%
	V2 (n=105)	29.5%	24.8%	22.9%	15.2%	5.7%	1.9%
White beans	C (n=99)$^{\alpha}$	50.5%	21.2%	14.1%	8.1%	5.1%	1.0%
	V1 (n=95)$^{\alpha\beta}$	69.5%	13.7%	6.3%	7.4%	3.2%	0.0%
	V2 (n=112)$^{\alpha}$	53.6%	14.3%	9.8%	13.4%	7.1%	1.8%
Chicken soup	C (n=97)	42.3%	34.0%	12.4%	6.2%	4.1%	1.0%
	V1 (n=113)	45.1%	31.0%	14.2%	7.1%	2.7%	0.0%
	V2 (n=100)	42.0%	34.0%	15.0%	4.0%	5.0%	0.0%
Broccoli cheddar soup	C (n=79) *	45.6%	24.1%	16.5%	5.1%	6.3%	2.5%
	V1 (n=54) *	38.9%	16.7%	29.6%	5.6%	7.4%	1.9%
	V2 (n=94) $^{*\beta}$	23.4%	27.7%	26.6%	14.9%	6.4%	1.1%
Potato salad	C (n=89)	36.0%	24.7%	20.2%	14.6%	4.5%	0.0%
	V1 (n=88)	35.2%	34.1%	17.0%	8.0%	4.5%	1.1%
	V2 (n=87)	27.6%	24.1%	18.4%	12.6%	13.8%	3.4%
Seafood salad	C (n=114)	24.6%	22.8%	24.6%	12.3%	10.5%	5.3%
	V1 (n=111)$^{\beta}$	38.7%	26.1%	18.9%	7.2%	5.4%	3.6%
	V2 (n=113)$^{\beta}$	39.8%	30.1%	17.7%	3.5%	7.1%	1.8%
Bacon cheeseburger	C (n=59) *	28.8%	32.2%	20.3%	11.9%	5.1%	1.7%
	V1 (n=110)	24.5%	17.3%	30.0%	9.1%	15.5%	3.6%
	V2 (n=112)	32.1%	21.4%	18.8%	17.9%	8.0%	1.8%
Greek salad	C (n=106)	39.6%	31.1%	14.2%	10.4%	3.8%	0.9%
	V1 (n=91)	38.5%	19.8%	18.7%	15.4%	5.5%	2.2%

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Menu Items	Item Version	Never	<1/mo	1/mo	1/2-3wk	>1/wk	>2/wk
	V2 (n=107)	42.1%	20.6%	16.8%	13.1%	7.5%	0.0%
Menu Items	**Item Version**	**Never**	**Rarely**	**Occasionally**	**Often**		
Chicken salad	C (n=83)	47.0%	12.0%	25.3%	15.7%		
	V1 (n=80)$^{\beta}$	36.3%	21.3%	27.5%	15.0%		
	V2 (n=79)	38.0%	19.0%	26.6%	16.5%		
Green salad with blue cheese	C (n=88)$^{\alpha}$	50.0%	20.5%	22.7%	6.8%		
	V1 (n=91)	44.0%	18.7%	26.4%	11.0%		
	V2 (n=93)$^{\alpha}$	50.5%	26.9%	18.3%	4.3%		
Meat Pizza	C (n=60)*	6.67%	11.7%	26.7%	55.0%		
	V1 (n=51)*	5.9%	5.9%	29.4%	58.8%		
	V2 (n=46)*	4.4%	10.9%	21.7%	63.0%		
Chicken casserole	C (n=73)	43.8%	17.8%	26.0%	12.3%		
	V1 (n=86)	37.2%	18.6%	23.3%	20.9%		
	V2 (n=80)	46.3%	15.0%	31.3%	7.5%		
Meat lasagna	C (n=79)	30.4%	20.3%	35.4%	13.9%		
	V1 (n=83)	24.1%	16.9%	42.2%	16.9%		
	V2 (n=80)	22.5%	26.3%	31.3%	20.0%		
Beef burger with blue cheese	C (n=92)	37.0%	18.5%	26.1%	18.5%		
	V1 (n=92)	30.4%	29.3%	31.5%	8.7%		
	V2 (n=90)	38.9%	20.0%	27.8%	13.3%		
Beef burger with barbecue sauce	C (n=89)	15.7%	19.1%	38.2%	27.0%		
	V1 (n=96)	18.8%	18.8%	31.3%	31.3%		
	V2 (n=91)$^{\beta}$	26.4%	15.4%	41.8%	16.5%		
Guacamole chicken burger	C (n=91)	38.5%	25.3%	22.0%	14.3%		
	V1 (n=91)	42.9%	31.9%	18.7%	6.6%		
	V2 (n=92)	38.0%	31.5%	19.6%	10.9%		

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Menu Items	Item Version	Never	<1/mo	1/mo	1/2-3wk	>1/wk	>2/wk
Italian sandwich	**C (n=101)**	31.7%	18.8%	21.8%	27.7%		
	V1 (n=137)	31.4%	25.5%	21.9%	21.2%		
	V2 (n=122)$^{\beta}$	43.4%	26.2%	19.7%	10.7%		
Turkey sandwich with bacon	**C (n=103)**	44.7%	24.3%	19.4%	11.7%		
	V1 (n=129)	38.8%	20.2%	24.0%	17.1%		
	V2 (n=127)	48.8%	18.9%	22.8%	9.4%		
Meatball sandwich	**C (n=126)**	42.1%	19.8%	23.0%	15.1%		
	V1 (n=107)$^{\beta}$	27.1%	29.0%	22.4%	21.5%		
	V2 (n=128)$^{\beta}$	31.3%	24.2%	26.6%	18.0%		
Beef and cheddar sandwich	**C (n=139)**	36.0%	12.2%	29.5%	22.3%		
	V1 (n=108)	45.4%	16.7%	25.9%	12.0%		
	V2 (n=114)	33.3%	21.9%	28.1%	16.7%		

C=current menu item

V1= slightly reduced calorie, fat, saturated fat and/or sodium version

V2=moderately reduced calorie, fat, saturated fat and/or sodium version

[*] Data were excluded due to recipe execution errors

[α] Fifty percent (50%) or more participants had never consumed the item tested

[β] Compared to C, consumption frequency differed by more than 10% in the Never category

No frequency data for seafood nachos, fish, creamy alfredo pasta with shrimp and seafood platter.

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Table 5

Calories, fat, saturated fat and sodium reduction per single serving for acceptable * modified recipe version

Menu Items	Calories (kcal)	Fat (g)	Saturated fat (g)	Sodium (mg)
Hummus	20	2	0	70
Seafood nachos	60	5	3	170
Chicken soup	0	0	0	120
Broccoli cheddar soup	50	2	1.5	280
Potato salad	20	3	0.5	110
Seafood salad	20	2	0	0
Chicken salad	30	4	0.5	60
Meat pizza	20	2	1	100
Creamy Alfredo pasta with shrimp	80	7	5	170
Chicken casserole	20	2	0	10
Meat lasagna	10	1	0.5	20
Bacon cheeseburger	210	20	8	640
Beef burger with blue cheese	210	15	4	320
Beef burger with barbecue sauce	90	7	1	60
Italian sandwich	140	13	2	220
Turkey sandwich with bacon	100	11	2	60
Meatball sandwich	90	8	3	190
Fish	40	3	2	90
Seafood platter	10	1	0	1940
Total Reduction	1220	108	34	4630

* Modified menu items were considered acceptable if, compared to the current version, the modified version showed: 1) no significant differences (or a significant increase in scores) on the 9-point scale for overall taste/flavor and overall opinion, 2) similar (i.e., within 5%) or an increased likelihood to purchase, 3) similar or an improvement in the JAR distributions and penalty analysis, and 4) similar (i.e., within 5%) or a decrease in alienation frequencies.

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Table 6

Likelihood to purchase each of the menu item versions

Menu Items	Likelihood to Purchase (%)* C (n=59 to 140)	V1 (n=51 to 137)	V2 (n=47 to 129)
Hummus	83	83	74
Seafood nachos	79	81	63
White beans	82	64	75
Chicken soup	74	80	73
Broccoli cheddar soup†	51	69	68
Potato salad	46	42	56
Seafood salad	61	59	49
Chicken salad	52	61	57
Green salad with blue cheese	63	52	52
Greek salad	81	78	71
Meat pizza†	82	90	83
Creamy Alfredo pasta with shrimp	50	54	60
Chicken casserole	51	64	56
Meat lasagna	53	62	49
Bacon cheeseburger†	76	85	77
Beef burger with blue cheese	56	57	54
Beef burger with barbecue sauce	78	81	67
Guacamole chicken burger	55	47	34
Italian sandwich	68	64	48
Turkey sandwich with bacon	61	62	53
Meatball sandwich	60	62	46
Beef and cheddar sandwich	82	64	55
Fish	52	51	51
Seafood platter	70	72	88

*Yes, definitely would or probably would order the menu item

†data were excluded due to recipe execution errors

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Table 7

Effect of recipe modifications on overall taste/flavor (mean scores +/− SD and +/− SE on 9-point hedonic scale)

	Overall Taste/Flavor								
	C (n= 60 to 138)			V1 (n= 48 to 137)			V2 (n=74 to 127)		
Menu Items	**Mean**	**±SD**	**±SE**	**Mean**	**±SD**	**±SE**	**Mean**	**±SD**	**±SE**
Hummus	7.5	1.7	0.2	7.8	1.5	0.2	7.5	1.5	0.2
Seafood nachos	7.7	1.5	0.2	7.9	1.4	0.2	7.5	1.5	0.1
White beans	7.6 (B)	1.8	0.2	6.9 (AC)	2.1	0.2	7.3 (B)	1.5	0.2
Chicken soup	7.6	1.2	0.1	7.6	1.1	0.1	7.5	1.3	0.1
Broccoli cheddar soup*	6.9	1.5	0.2	7.2	1.8	0.2	7.0	1.6	0.2
Potato salad	6.1	2.2	0.2	6.3	1.9	0.2	6.6	1.8	0.2
Seafood salad	6.8	2.2	0.2	6.9	1.7	0.2	6.4	2.0	0.2
Chicken salad	6.8	1.9	0.2	6.9	2.0	0.2	7.1	2.0	0.2
Green salad with blue cheese	7.7 (C)	1.2	0.2	7.3	1.5	0.2	7.1 (A)	1.7	0.2
Greek salad	7.8 (C)	1.2	0.1	7.8 (C)	1.3	0.1	7.4 (AB)	1.6	0.1
Meat pizza**	7.8	1.2	0.2	8.1	1.2	0.2	7.7	1.1	0.2
Creamy Alfredo pasta with shrimp	7.0	1.7	0.2	7.2	1.5	0.2	7.1	1.6	0.1
Chicken casserole	7.0	1.7	0.2	7.2	1.9	0.2	7.4	1.4	0.2
Meat lasagna	6.4	1.9	0.2	6.9	2.0	0.2	6.6	2.1	0.2
Bacon cheeseburger*	7.7	1.4	0.2	7.8	1.0	0.1	7.8	1.5	0.1
Beef burger with blue cheese	7.0	2.1	0.2	7.3	1.6	0.2	7.1	1.6	0.2
Beef burger with barbecue sauce	7.9	1.0	0.1	8.0	1.2	0.1	7.7	1.2	0.1
Guacamole chicken burger	7.1 (C)	1.5	0.2	6.8	1.6	0.2	6.5 (A)	1.9	0.2
Italian sandwich	7.8 (C)	1.4	0.1	7.7 (C)	1.4	0.1	7.4 (AB)	1.3	0.1
Turkey sandwich with bacon	7.6	1.3	0.1	7.6	1.3	0.1	7.2	1.5	0.1
Meatball sandwich	7.4	1.6	0.1	7.7	1.5	0.1	7.4	1.5	0.1
Beef and cheddar sandwich	8.2 (BC)	1.1	0.1	7.9 (A)	1.2	0.1	7.5 (A)	1.5	0.1
Fish	7.0	1.7	0.2	6.9	1.7	0.2	6.9	1.8	0.2
Seafood platter	7.4	1.7	0.1	7.8	1.6	0.1	8.3 (AB)	0.8	0.1

Generalized Linear Regression Model analysis, 95% CL; Values are expressed as means

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9-point hedonic scale: 1=dislike extremely and 9=like extremely

C=current menu item

V1= slightly reduced calorie, fat, saturated fat and/or sodium version

V2=moderately reduced calorie, fat, saturated fat and/or sodium version

(A) Differ significantly ($p<0.05$) compared to current recipe; (B) differ significantly ($p<0.05$) compared to slightly modified version 1 recipe; (C) differ significantly ($p<0.05$) compared to slightly modified version 2 recipe.

*data were excluded due to recipe execution errors

**data from one restaurant location were excluded because the Italian sausage product used was different from the product used at the other three locations

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Table 8

Just-About-Right (JAR) distributions and penalty analysis for saltiness and amount of dressing for selected menu items

		Saltiness (n=53 to 112)		
Menu Items		**Not Salty Enough (%)**	**Just Right (%)**	**Too Salty (%)**
Hummus	C	10	81	9
	V1	12	84	4
	V2	16	78	6
Chicken Soup	C	6	61	**33**
	V1	4	57	**39**
	V2	8	64	**28**
Broccoli Cheddar Soup†^	C	5	60	**35**
	V1	4	72	**23**
	V2	4	61	**34**
Potato Salad†	C	18	70	12
	V1	14	73	14
	V2	13	79	8
Seafood Platter	C	4	60	**36***
	V1	7	58	**35***
	V2	3	70	**27**
		Amount of Dressing (n=78 to 113)		
Menu Items		Not Enough (%)	Just Right (%)	Too Much (%)
Potato Salad	C	2	46	**52***
	V1	0	29	**71***
	V2	1	51	**48***
Seafood Salad	C	12	64	**25***
	V1	6	62	**33**
	V2	14	49	**37***
Chicken Salad	C	4	57	**40***
	V1	9	60	**31***
	V2	9	67	**24**

Frequencies>=20%in the extremes of the scale are highlighted in grey

*Penalty indicated for frequencies >=20% and >0.75 mean drop on overall liking 9-point hedonic scale

†Data were excluded due to recipe execution and/or questionnaire errors

^Penalty analysis was not performed due to low n-values

Percentages may not total 100% due to rounding

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